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Kawata et al.

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(54) **ADAPTER FOR ENDOSCOPE, PROCESSOR FOR ENDOSCOPE AND ENDOSCOPE SYSTEM**

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(22) Filed: **Nov. 29, 2012**

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(51) **Int. Cl.**
H04N 7/18 (2006.01)

(52) **U.S. Cl.**
USPC **348/65**

(58) **Field of Classification Search**
USPC 348/56
See application file for complete search history.

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(57) **ABSTRACT**

An adapter for endoscope includes: an image pickup device driving signal generation circuit; an image signal output circuit; an endoscope identification information reception circuit receiving endoscope ID information; a ROM storing adapter ID information about the adapter; a flash memory storing parameters for adjustment; and a control section performing control to store the parameters for adjustment into the flash memory according to a command from a processor to write the parameters for adjustment, and read the parameters for adjustment stored in the flash memory and output the parameters for adjustment stored in the flash memory to the processor according to a command from the processor to read the parameters for adjustment.

9 Claims, 6 Drawing Sheets

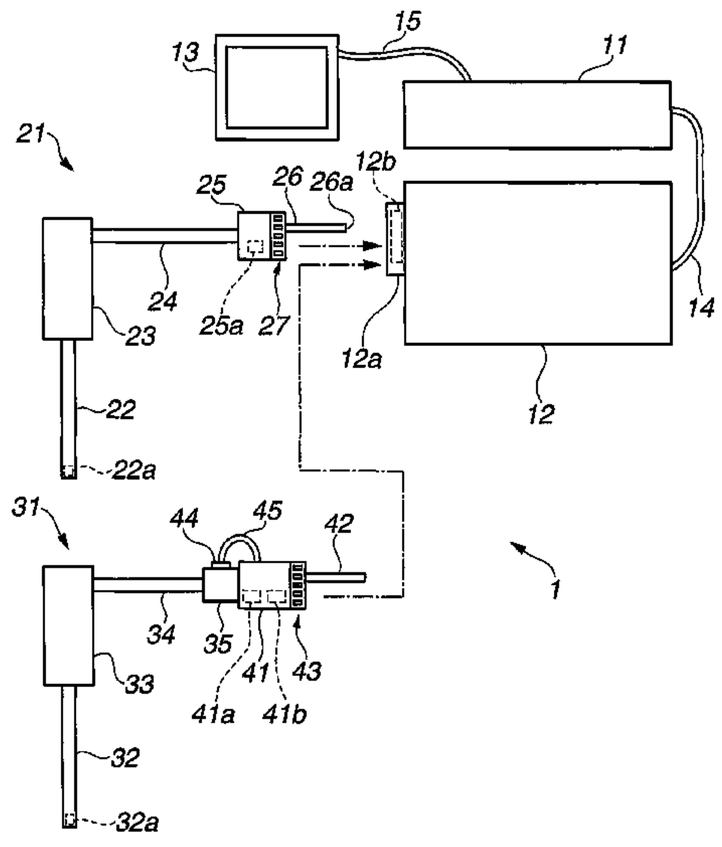
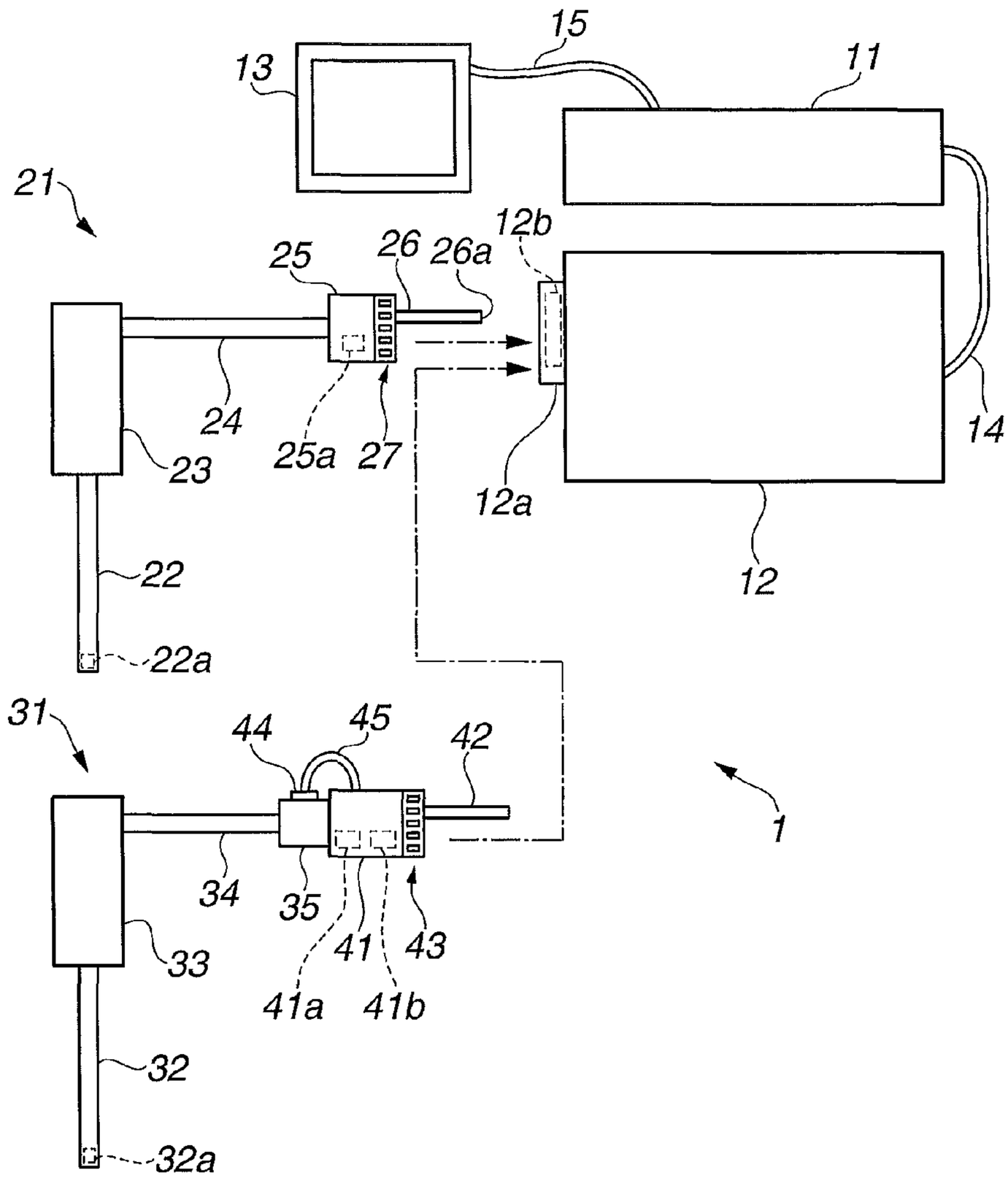


FIG.1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13
11
21
12b
25
26
26a
24
25a
27
23
12a
14
22
12
22a
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42
34
35
41
43
33
41a
41b
32
32a
1

FIG.2

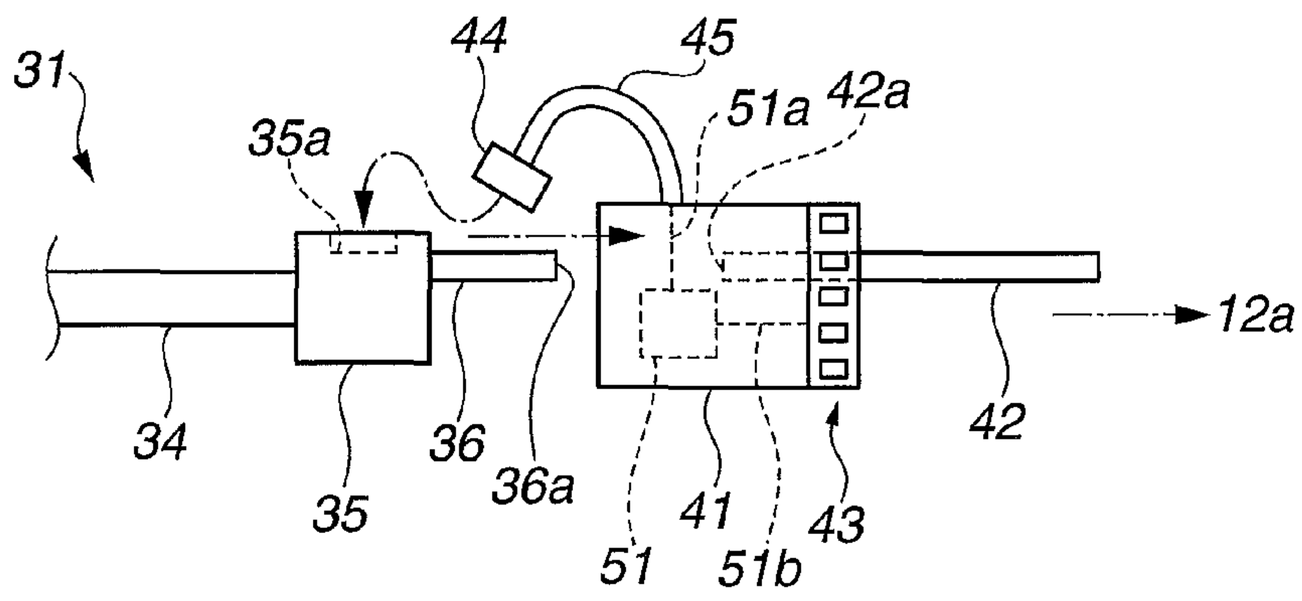

31
44
45
35a
51a
42a
12a
34
35
36
36a
41
43
42
51
51b

FIG.3

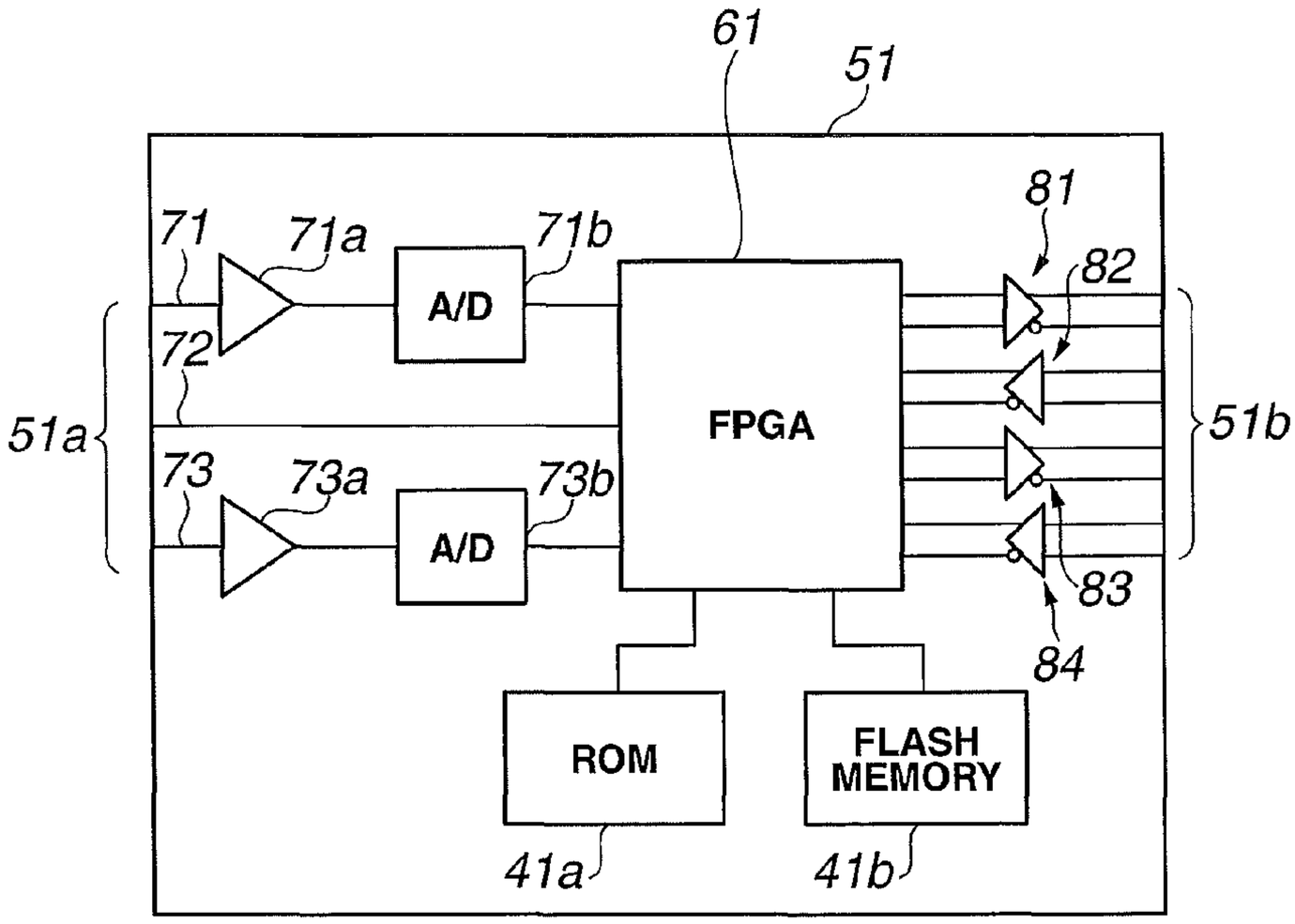

61
51
71
71a
71b
A/D
72
81
82
FPGA
51a
51b
73
73a
73b
A/D
83
84
ROM
FLASH MEMORY
41a
41b

FIG.4

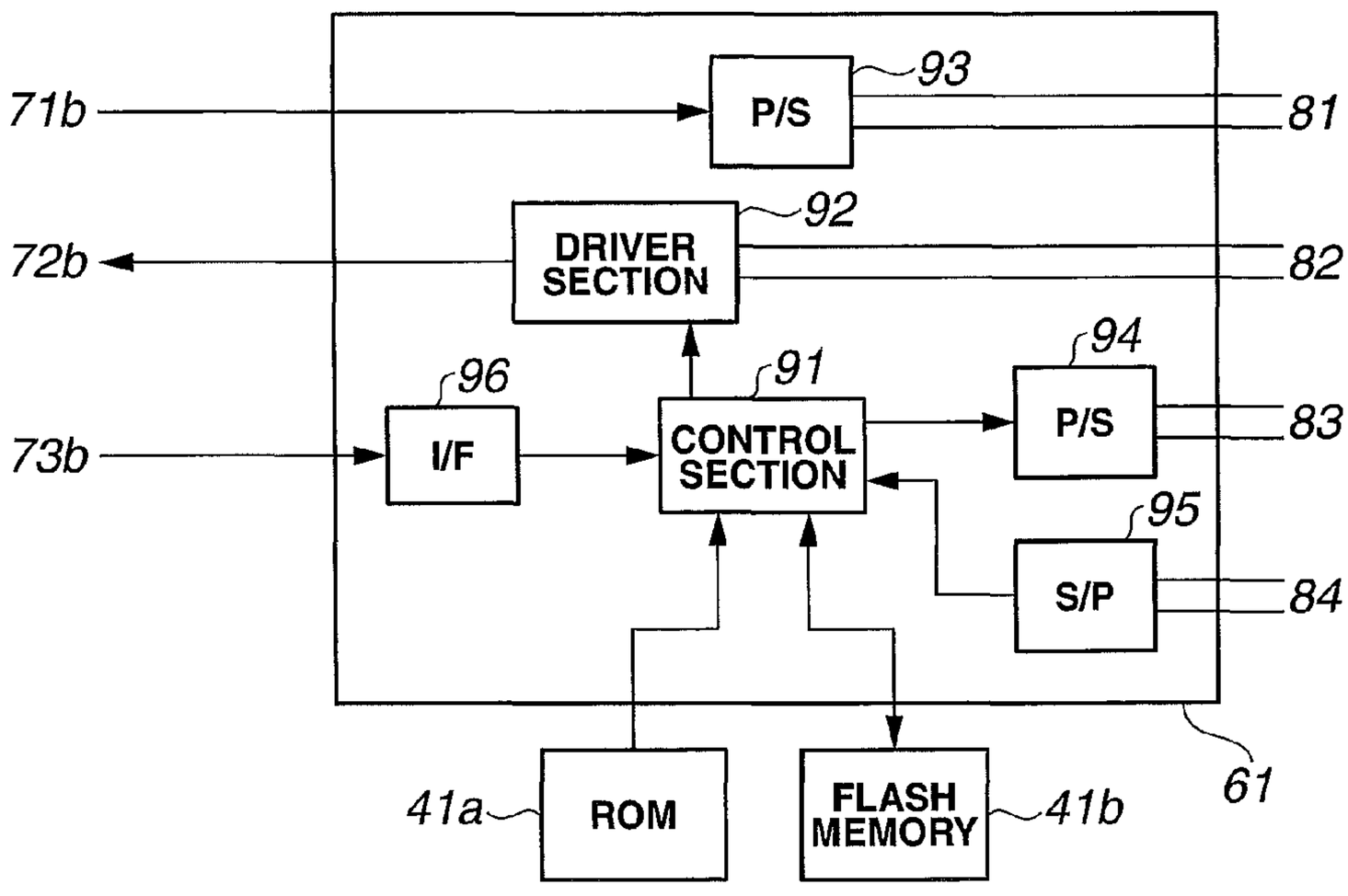

71b
P/S
93
81
72b
DRIVER SECTION
92
82
94
96
91
73b
I/F
CONTROL SECTION
P/S
83
95
S/P
84
61
41a
ROM
FLASH MEMORY
41b

FIG.5

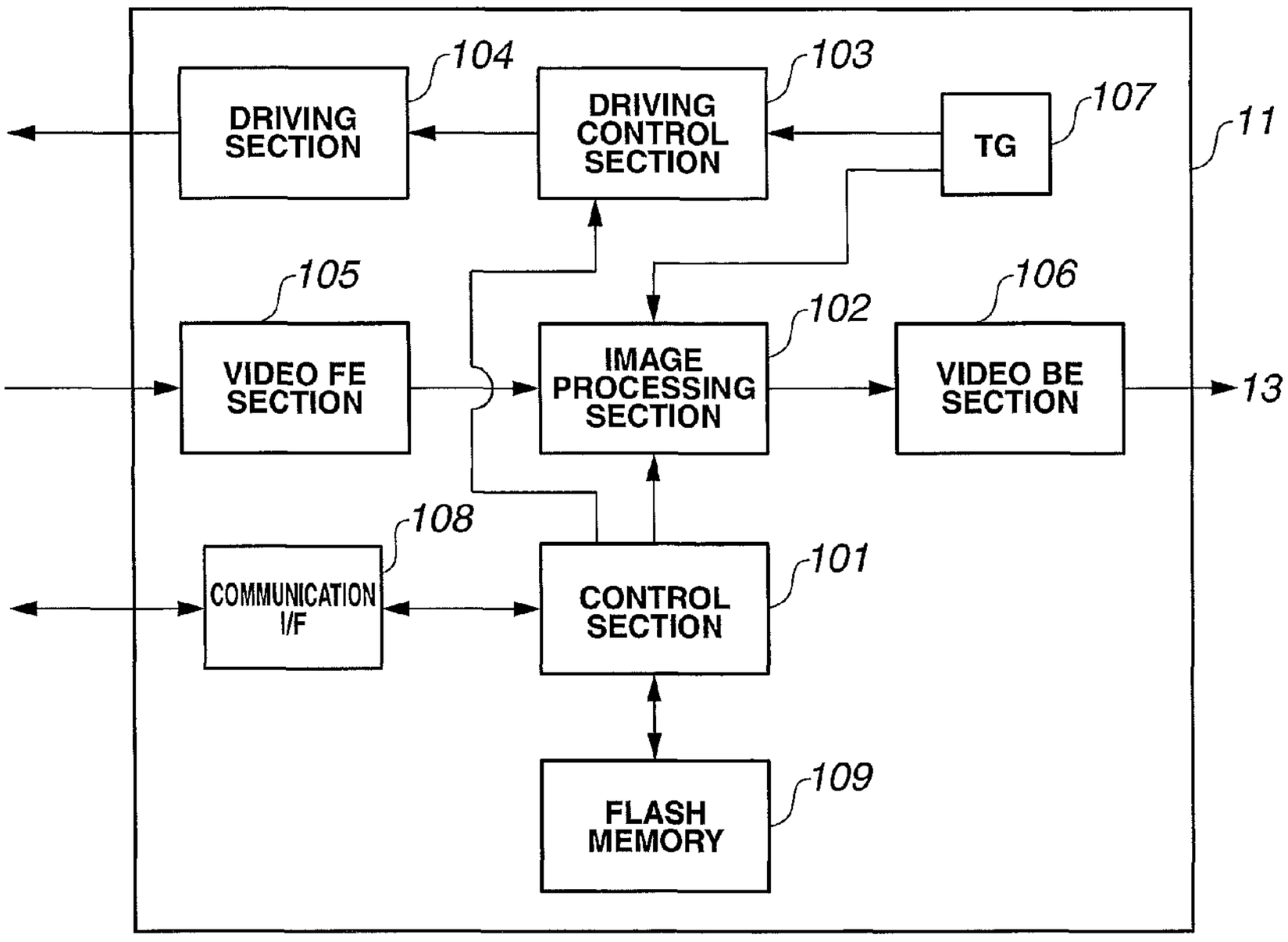

DRIVING SECTION
104
DRIVING CONTROL SECTION
103
TG
107
11
VIDEO FE SECTION
105
IMAGE PROCESSING SECTION
102
VIDEO BE SECTION
106
13
COMMUNICATION I/F
108
CONTROL SECTION
101
FLASH MEMORY
109

FIG.6

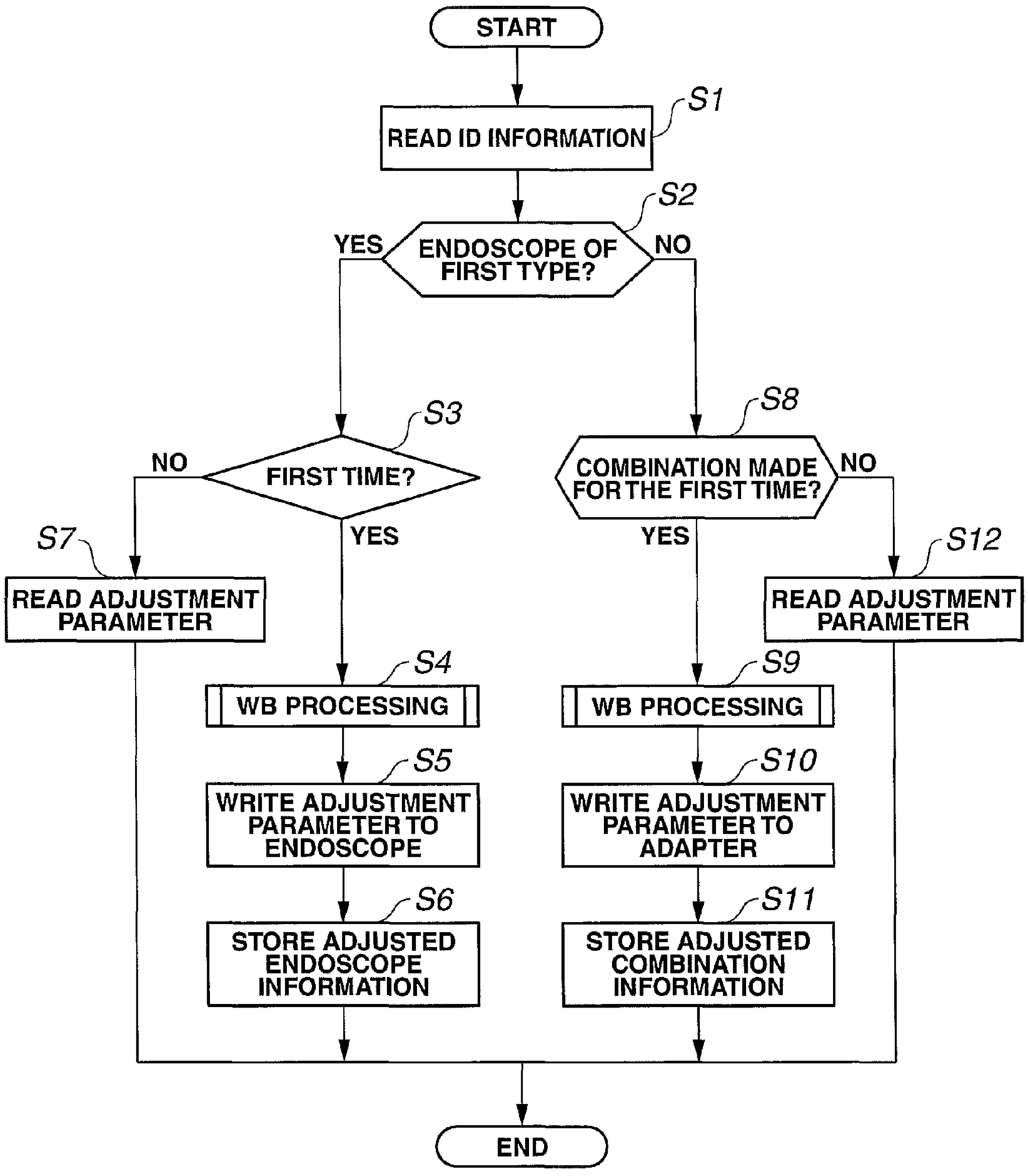

START
READ ID INFORMATION
S1
ENDOSCOPE OF FIRST TYPE?
S2
YES
NO
FIRST TIME?
S3
NO
YES
READ ADJUSTMENT PARAMETER
S7
WB PROCESSING
S4
WRITE ADJUSTMENT PARAMETER TO ENDOSCOPE
S5
STORE ADJUSTED ENDOSCOPE INFORMATION
S6
COMBINATION MADE FOR THE FIRST TIME?
S8
NO
YES
READ ADJUSTMENT PARAMETER
S12
WB PROCESSING
S9
WRITE ADJUSTMENT PARAMETER TO ADAPTER
S10
STORE ADJUSTED COMBINATION INFORMATION
S11
END

FIG.7

TBL1

ENDOSCOPE ID INFORMATION
ENDO1SN0001
ENDO1SN0010
ENDO1SN0002
ENDO1SN0022
. . .

FIG.8

TBL2

COMBINATION	ADAPTER ID INFORMATION	ENDOSCOPE ID INFORMATION
1	ADP1ZZ0001	ENDO2SN0100
2	ADP1ZZ0001	ENDO2SN0111
3	ADP2ZZ0010	ENDO2SN0033
4	ADP2ZZ0010	ENDO2SN0100
. . .	. . .	. . .

FIG.9

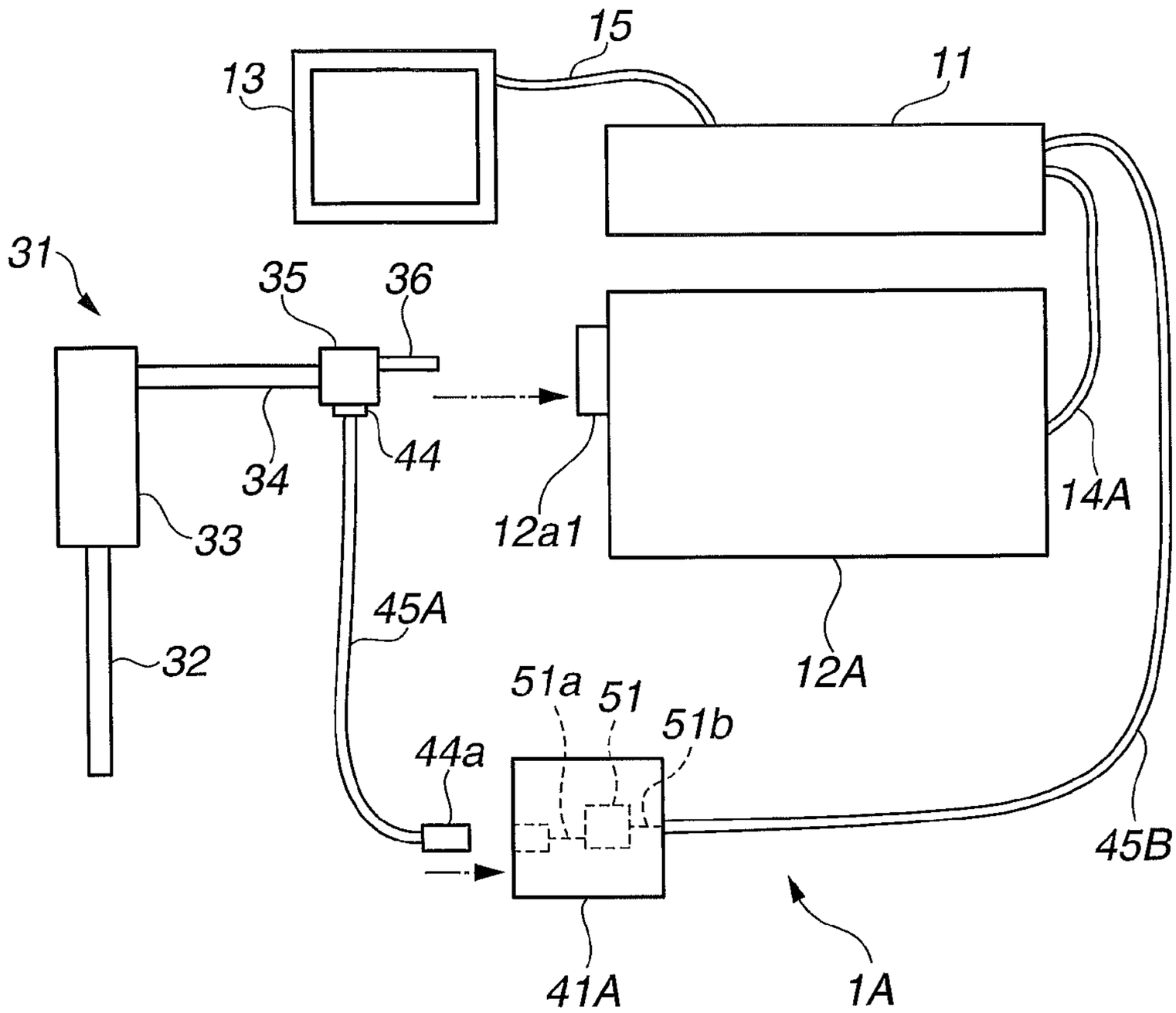
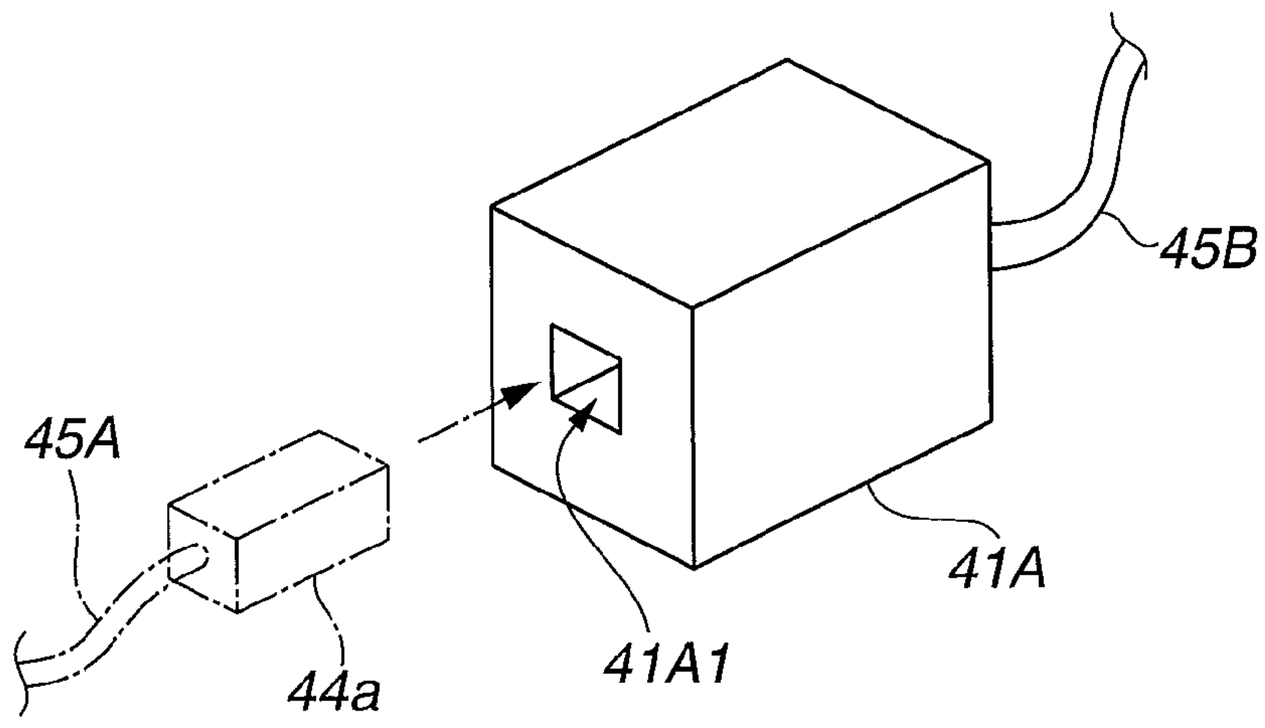

15
13
11
31
35
36
34
44
33
12a1
14A
45A
32
12A
51a
51
51b
44a
45B
41A
1A

FIG.10


45B
45A
41A
44a
41A1

ADAPTER FOR ENDOSCOPE, PROCESSOR FOR ENDOSCOPE AND ENDOSCOPE SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation application of PCT/JP2011/076509 filed on Nov. 17, 2011 and claims benefit of Japanese Application No. 2011-073370 filed in Japan on Mar. 29, 2011, the entire contents of which are incorporated herein by this reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an adapter for endoscope, a processor for endoscope and an endoscope system.

2. Description of the Related Art

Conventionally, an endoscope system has been widely used in a medical field and an industrial field. The endoscope system makes it possible to perform observation, image recording and the like of an endoscopy target site by inserting an endoscope insertion portion of the endoscope system into an inside of a patient's body cavity or into an inside of an endoscopy object.

When a detachable endoscope is connected to a processor, the processor generates a driving signal for driving an image pickup device provided at a distal end portion of the endoscope insertion portion, performs image processing of an image signal, which is a video signal from the image pickup device, and displays an endoscopic image on a monitor. At that time, the processor cannot generate an appropriate endoscopic image without performing white balance adjustment of the endoscopic image. That is, the processor can generate an appropriate endoscopic image and output the endoscopic image on the monitor by obtaining various parameters for adjustment including a coefficient for white balance adjustment and the like, driving the endoscope on the basis of the parameters for adjustments and performing image processing of a received image signal.

For example, as shown in Japanese Patent Application Laid-Open Publication No. 05-176886, an endoscope apparatus is proposed which enables an endoscope holding parameters for adjustment, such as various gains, as respective resistance values of variable resistors to be connected to a processor via an adapter. The processor reads the resistance value via the adapter, discriminates parameters for adjustment from the resistance value, and performs driving and image processing of each endoscope on the basis of the discriminated various parameters for adjustment.

Recently, a new type of endoscope has been also proposed which includes a rewritable nonvolatile memory which stores the various parameters for adjustment.

According to the new type of endoscope which stores the various parameters for adjustment, according to the proposal, a processor identifies the endoscope on the basis of identification information about the endoscope connected, and performs various adjustments such as white balance adjustment if the identified endoscope is an endoscope connected for the first time. The processor obtains the various parameters for adjustment then and stores the various parameters for adjustment into the nonvolatile memory of the endoscope.

In the case of using the endoscope with such a configuration in combination with the processor, the processor judges whether or not the endoscope is an endoscope which has been previously connected when the endoscope is connected. If the endoscope is an endoscope which has been previously connected, the processor reads the various parameters for adjustment from the endoscope and uses the parameters for driving an image pickup device, image processing of an image signal and the like. Thus, after performing white balance adjustment and the like once, a user is not required to perform adjustment works such as white balance adjustment each time he uses the endoscope afterwards.

SUMMARY OF THE INVENTION

An adapter for endoscope according to an aspect of the present invention is an adapter for endoscope connecting an endoscope provided with an image pickup device which analog signals are inputted to and outputted from and a processor which digital signals are inputted to and outputted from; and the adapter is provided with: an image pickup device driving signal generation circuit generating a driving signal for driving the image pickup device on the basis of a driving control signal from the processor; an image signal output circuit converting an analog image signal from the image pickup device to a digital image signal in a serial signal format and outputting the digital image signal to the processor; an endoscope identification information reception circuit receiving endoscope identification information which is identification information about the endoscope; an adapter identification information storage section storing adapter identification information which is identification information about the adapter for endoscope; an information transmission section transmitting the endoscope identification information and the adapter identification information to the processor; a parameter-for-adjustment storage section storing parameters for adjustment; and a control section performing control to store the parameters for adjustment received from the processor into the parameter-for-adjustment storage section according to a command to write the parameters for adjustment from the processor which is configured to receive the endoscope identification information and the adapter identification information, and read the parameters for adjustment stored in the parameter-for-adjustment storage section according to a command to read the parameters for adjustment from the processor and output the parameters for adjustment to the processor.

A processor for endoscope according to an aspect of the present invention is a processor capable of inputting and outputting digital signals to and from an adapter for endoscope to which an endoscope is connectable, the endoscope being provided with an image pickup device which analog signals are inputted to and outputted from, wherein the adapter for endoscope comprises: an image pickup device driving signal generation circuit generating a driving signal for driving the image pickup device on the basis of a driving control signal from the processor; an image signal output circuit converting an analog image signal from the image pickup device to a digital image signal in a serial signal format and outputting the digital image signal to the processor; an endoscope identification information reception circuit receiving endoscope identification information which is identification information about the endoscope; an adapter identification information storage section storing adapter identification information which is identification information about the adapter for endoscope; an information transmission section transmitting the endoscope identification information and the adapter identification information to the processor; a parameter-for-adjustment storage section storing parameters for adjustment; and a control section performing control to store the parameters for adjustment received from the proces-

sor into the parameter-for-adjustment storage section according to a command to write the parameters for adjustment from the processor which is configured to receive the endoscope identification information and the adapter identification information, and read the parameters for adjustment stored in the parameter-for-adjustment storage section according to a command to read the parameters for adjustment from the processor and output the parameters for adjustment to the processor; and the processor comprises: an adjusted combination information storage section storing adjusted combination information showing whether predetermined adjustment processing has been performed or not for a combination of the endoscope identification information and the adapter identification information; and a control section judging existence or nonexistence of the adjusted combination information about a combination of the endoscope identification information and the adapter identification information received from the adapter for endoscope by referring to the adjusted combination information storage section; if the adjusted combination information does not exist, executing the predetermined adjustment processing, storing the parameters for adjustment obtained by the execution into the parameter-for-adjustment storage section of the adapter for endoscope and storing the adjusted combination information about the combination of the endoscope identification information and the adapter identification information into the adjusted combination information storage section; and, if the adjusted combination information exists, reading the parameters for adjustment stored in the parameter-for-adjustment storage section of the adapter for endoscope.

An endoscope system according to an aspect of the present invention is an endoscope system comprising: an adapter for endoscope to which an endoscope is connectable, the endoscope being provided with an image pickup device which analog signals are inputted to and outputted from; and a processor which digital signals are inputted to and outputted from, wherein the adapter for endoscope comprises: an image pickup device driving signal generation circuit generating a driving signal for driving the image pickup device on the basis of a driving control signal from the processor; an image signal output circuit converting an analog image signal from the image pickup device to a digital image signal in a serial signal format and outputting the digital image signal to the processor; an endoscope identification information reception circuit receiving endoscope identification information which is identification information about the endoscope; an adapter identification information storage section storing adapter identification information which is identification information about the adapter for endoscope; an information transmission section transmitting the endoscope identification information and the adapter identification information to the processor; a parameter-for-adjustment storage section storing parameters for adjustment; and a control section performing control to store the parameters for adjustment received from the processor into the parameter-for-adjustment storage section according to a command to write the parameters for adjustment from the processor which is configured to receive the endoscope identification information and the adapter identification information, and read the parameters for adjustment stored in the parameter-for-adjustment storage section according to a command to read the parameters for adjustment from the processor and output the parameters for adjustment to the processor; and the processor comprises: an adjusted combination information storage section storing adjusted combination information showing whether predetermined adjustment processing has been performed or not for a combination of the endoscope identification information and the adapter identification information; and a control section judging existence or nonexistence of the adjusted combination information about a combination of the endoscope identification information and the adapter identification information received from the adapter for endoscope by referring to the adjusted combination information storage section; if the adjusted combination information does not exist, executing the predetermined adjustment processing, storing the parameters for adjustment obtained by the execution into the parameter-for-adjustment storage section of the adapter for endoscope and storing the adjusted combination information about the combination of the endoscope identification information and the adapter identification information into the adjusted combination information storage section; and, if the adjusted combination information exists, reading the parameters for adjustment stored in the parameter-for-adjustment storage section of the adapter for endoscope.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a configuration diagram showing a configuration of an endoscope system according to an embodiment of the present invention;

FIG. **2** is a diagram for illustrating a configuration of an adapter **41** according to the embodiment of the present invention;

FIG. **3** is a block configuration diagram of a board **51** of the adapter **41** according to the embodiment of the present invention;

FIG. **4** is a block configuration diagram of an FPGA **61** according to the embodiment of the present invention;

FIG. **5** is a block configuration diagram of a processor **11** according to the embodiment of the present invention;

FIG. **6** is a flowchart showing an example of a flow of a parameter-for-adjustment acquisition and writing process of the processor **11**, according to the embodiment of the present invention;

FIG. **7** is a diagram showing a configuration of a table for storing adjusted endoscope information about endoscopes **21** of a first type, according to the embodiment of the present invention;

FIG. **8** is a diagram showing a configuration of a table for storing adjusted combination information about endoscopes **31** of a second type and the adapters **41**, according to the embodiment of the present invention;

FIG. **9** is a diagram for illustrating a configuration example of an endoscope system **1**A using an adapter **41**A according to a variation of the embodiment of the present invention; and

FIG. **10** is a perspective view of the adapter **41**A according to the variation of the embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will be described below with reference to drawings.

(System Configuration)

FIG. **1** is a configuration diagram showing a configuration of an endoscope system according to the present embodiment. An endoscope system **1** includes a processor **11** which digital signals are inputted to or outputted from to perform image processing and the like, a light source apparatus **12**, and a monitor **13** as a display apparatus. The processor **11** and the light source apparatus **12** are connected via a cable **14**, and the processor **11** and the monitor **13** are connected via a cable **15**. In the endoscope system **1** according to the present

embodiment, two types of endoscopes **21** and **31** are connectable to the light source apparatus **12**.

The endoscope **21** of the first type is configured to include a flexible or rigid insertion portion **22**, an operation section **23**, a cable **24** and a connector **25** connected to the proximal end of the cable **24**. An image pickup device **22***a* is mounted inside the distal end portion of the insertion portion **22**. The endoscope **21** is attachable to and detachable from a connector portion **12***a* of the light source apparatus **12** via the connector **25**.

The connector **25** has a light guide **26**, which is a protruding end portion of a light guide for illumination, and an electrical contact section **27** which includes multiple contact points for various electrical signals. The connector portion **12***a* has an electrical contact section **12***b* having multiple contact points, which corresponds to the contact section **27**, and a light guide connector portion (not shown) for connecting a light guide **12***c* corresponding to the light guide **26**.

Note that, though the connector **25** and the connector portion **12***a* also have connection portions for an air/water feeding function, the connection portions for air/water feeding are not shown, and description thereof is omitted.

The connector portion **12***a* is configured so that, when the connector **25** is connected to the connector portion **12***a* of the light source apparatus **12**, illumination light from a lamp (not shown) in the light source apparatus **12** is condensed on an end face **26***a* of the light guide **26**, and the contact section **27** of the connector **25** and the contact section **12***b* of the connector portion **12** are in contact with each other.

Therefore, when the connector **25** is connected to the connector portion **12***a* of the light source apparatus **12**, light from the light source apparatus **12** passes through the light guide **26** of the connector **25** and a light guide inserted through the endoscope **21** and is radiated from the distal end of the insertion portion **22** as illumination light. Furthermore, by connecting the connector **25** to the connector portion **12***a* of the light source apparatus **12**, driving control of the image pickup device **22***a* arranged at the distal end of the insertion portion **22** from the processor **11** and reception of an image signal, which is a video signal from the image pickup device **22***a*, at the processor **11** become possible via the contact section **27**. Furthermore, an operation signal of the operation section **23** is also transmitted to the processor **11** via the contact section **27**.

The endoscope **21** has a flash memory **25***a*, which is a nonvolatile memory for storing an identifier specific to the endoscope **21** (hereinafter referred to as endoscope ID information) and various parameter data for adjustment, for example, in the connector **25**. The endoscope ID information may be stored in a ROM provided separately.

As described later, when the endoscope **21** is connected to the processor **11** for the first time, a user performs white balance adjustment, and, at that time, the processor **11** executes white balance processing, acquires various parameters for adjustment and stores the various parameters for adjustment into the flash memory **25***a* of the endoscope **21**. At the same time, the processor **11** stores endoscope ID information about the endoscope **21** for which the white balance adjustment has been performed. Thus, when the endoscope **21** is connected, the processor **11** can read the endoscope ID information about the endoscope **21** and judge whether the endoscope **21** has been connected for the first time or has been already connected in the past, on the basis of the read endoscope ID information.

As described above, the connector **25** of the endoscope **21** can be connected to the light source apparatus **12** by a one-touch operation, and parameters for adjustment, such as a coefficient for white balance adjustment, are stored in the flash memory **25***a* of the endoscope **21**. Then, when the endoscope **21** is connected to the processor **11** again, the processor **11** can generate a driving clock signal for driving the image pickup device **22***a* and perform image processing, using the parameters for adjustment stored in the flash memory **25***a* of the endoscope **21**, and, therefore, the user need not perform adjustment work.

On the other hand, the endoscope **31** of the second type is configured to include an insertion portion **32**, an operation section **33**, a cable **34** and a connector **35** connected to the proximal end of the cable **34**. An image pickup device **32***a* which analog signals are inputted to or outputted from is mounted inside the distal end portion of the insertion portion **32**.

As described later, an adapter for endoscope (hereinafter referred to as an adapter) **41** is configured such that it is connectable to the connector **35** of the endoscope **31**, and, therefore, the endoscope **31** can be detachably connected to the connector portion **12***a* of the light source apparatus **12** via the adapter **41** by fitting the adapter **41** to the connector **35**. The adapter **41** includes a ROM **41***a* which stores ID information about the adapter **41** (hereinafter referred to as adapter ID information) and a flash memory **41***b* which is a nonvolatile memory capable of storing various parameters for adjustment.

The endoscope **31** of the second type also has endoscope ID information, but the endoscope **31** is an endoscope of a type which cannot store parameters for adjustment such as a coefficient for white balance adjustment, in combination with the processor **11**. For example, the endoscope **31** of the second type is an old type of endoscope, and has originally been used being connected to another light source apparatus and another processor. That is, though the endoscope **31** of the second type is used in combination with another processor, it can be used in combination with the new processor **11** for the endoscope **21** of the first type by using the adapter **41**.

(Adapter)

FIG. **2** is a diagram for illustrating a configuration of the adapter **41**. As shown in FIG. **2**, the adapter **41** is configured such that it is connectable to the connector **35** of the endoscope **31**. Furthermore, the adapter **41** is configured such that it is also connectable to the connector portion **12***a* of the light source apparatus **12**. Therefore, the adapter **41** has a light guide **42**, which is a protruding end portion of a light guide for illumination, and an electrical contact section **43** which includes multiple contact points for various electrical signals. That is, the adapter **41** is an adapter for endoscope which connects the endoscope **31** provided with the image pickup device **32***a* which analog signals are inputted to and outputted from and the processor **11** which digital signals are inputted to and outputted from.

The configuration of the contact section **43** is similar to that of the contact section **27** of the connector **25** of the endoscope **21**.

The adapter **41** is configured such that, when the connector **35** is connected therewith, an end face **36***a* of a light guide **36** protruding on the proximal end side of the connector **35** is in contact with an end face **42***a* on the distal end side of the light guide **42** of the adapter **41**. When the adapter **41** is connected to the connector portion **12***a* of the light source apparatus **12**, illumination light from the lamp (not shown) in the light source apparatus **12** is condensed on the proximal end of the light guide **42**. Therefore, the light guide **42** is a light transmission member which transmits light from the light source apparatus **12** to the light guide **36** of the endoscope **31**.

Furthermore, the adapter **41** has an electrical connector **44** for connecting to an electrical connector **35***a* of the connector **35**. The connector **44** is provided at the end portion of a cable **45** extended from the adapter **41**.

Furthermore, the adapter **41** includes a circuit board **51** on which various circuits to be described later are mounted. The circuit board **51** is connected to the cable **45** via various signal lines **51***a* and connected to the contact section **43** via various signal lines **51***b*.

By connecting the adapter **41** to which the connector **35** is connected, to the connector portion **12***a* of the light source apparatus **12**, light from the light source apparatus **12** passes through the light guide **42** of the adapter **41**, the light guide **36** of the connector **35** and a light guide (not shown) inserted through the endoscope **31** and is irradiated from the distal end of the insertion portion **32** as illumination light. Furthermore, by connecting the adapter **41** to which the connector **35** is connected, to the connector portion **12***a* of the light source apparatus **12**, the processor **11** can provide a driving signal to the image pickup device **32***a* arranged at the distal end of the insertion portion **32** and receive an image signal, which is a video signal from the image pickup device **32***a,* via the electrical connectors **35***a* and **44**, the cable **45** and the contact section **43**. Furthermore, an operation signal of the operation section **33** is also transmitted to the processor **11** via the contact section **43**.

More specifically, by connecting the connector **35** of the endoscope **31** of the second type to the adapter **41**, connecting the electrical connector **44** to the electrical connector **35***a* and fitting the adapter **41** to the connector portion **12***a* of the light source apparatus **12**, the circuit board **51** and the endoscope **31** are connected via the various signal lines **51***a,* the cable **45**, and the electrical connectors **44** and **35***a,* and, furthermore, the circuit board **51** and the processor **11** are connected via the various signal lines **51***b,* the contact sections **43** and **12***b,* and the cable **14**.

As described above, the processor **11** can not only connect the endoscope **21** of the first type but also connect the endoscope **31** of the second type by using the adapter **41**.

As described above, the endoscope **21** of the first type includes the flash memory **25***a* capable of storing ID information specific to the endoscope **21** of the first type and various parameters for adjustment inside the endoscope **21**, and the processor **11** can read the information in the memory and write various parameters for adjustment.

Therefore, though the user is required to perform various adjustments such as white balance adjustment when he uses the endoscope **21** of the first type for the first time, he is not required to perform the various adjustments because the processor **11** reads the various parameter information for adjustment from the memory of the endoscope **21**.

For example, when using multiple endoscopes **21** in combination with the processor **11**, the user is required to perform various adjustments at the time of using each endoscope for the first time, but he does not have to perform any adjustment at all at the time of using the endoscope the second and succeeding times. Therefore, usability of using a combination of multiple endoscopes **21** and the processor **11** is good for the user.

As described above, though the endoscope **31** of the second type has ID information on the basis of a resistance value of a variable resistor or the like, the endoscope **31** is a type of endoscope which cannot store various parameters for adjustment in combination with the processor **11**. The endoscope **31** of the second type is originally used in combination with another processor, it is necessary to perform various adjustment works each time of using the endoscope **31**, and the processor has to acquire information about various parameters for adjustment, which is troublesome for the user.

In a hospital or the like where multiple endoscopes of the first type and multiple endoscopes of the second type are used, it is complicated from the viewpoint of operation to use processors corresponding to the different types, and, furthermore, it is troublesome for a user that the way of using is different between the two types.

By using the adapter **41** described above, however, the user can use the endoscope **31** of the second type with usability similar to that of the endoscope **21** of the first type.

FIG. **3** is a block configuration diagram of the board **51** of the adapter **41**. The board **51** includes a field programmable gate array (hereinafter referred to as an FPGA) **61** which executes various processes, the ROM **41***a* and the flash memory **41***b*.

The various signal lines **51***a* are connected to signal lines **71**, **72** and **73** implemented on the board **51**, respectively. The signal line **71** is a signal line for receiving an image signal from the image pickup device of the endoscope **31**. The signal line **72** is a signal line for outputting a driving pulse signal which drives the image pickup device. The signal line **73** is a signal line for receiving an analog signal corresponding to endoscope ID information about the endoscope **31**.

The board **51** includes: a buffer circuit **71***a* which is connected to the signal line **71** and which receives an image signal; an analog-digital converter (hereinafter referred to as an A/D converter) **7** lb connected to the buffer circuit **71***a;* a buffer circuit **73***a* which is connected to the signal line **73** and which receives an analog signal corresponding to endoscope ID information; and an A/D converter **73***b* connected to the buffer circuit **73***a*. The buffer circuit **73***a,* the A/D converter **73***b* and an I/F **96** constitute an endoscope identification information reception circuit which receives endoscope identification information, which is identification information about the endoscope **31**.

Note that, when the endoscope ID information can be received from the endoscope **31** by a digital signal, the A/D converter **73***b* is unnecessary.

Furthermore, the various signal lines **51***b* are connected to a differential output circuit **81**, a differential input circuit **82**, a differential output circuit **83** and a differential input circuit **84** which are implemented on the board **51**, respectively. The differential output circuit **81** is a circuit for outputting an image signal from the image pickup device **32***a* of the endoscope **31** to the processor **11** by a differential signal. The differential input circuit **82** is a circuit for inputting a driving clock signal from the processor **11** to the image pickup device **32***a* of the endoscope **31** by a differential signal. The differential output circuit **83** is a circuit for outputting data read from the ROM **41***a* and the flash memory **41***b* to the processor **11** by a differential signal. The differential input circuit **84** is a circuit for receiving various commands from the processor **11** and data from the processor **11** to be written into the flash memory **41***b* by a differential signal.

The FPGA **61** executes a process of converting a parallel image signal from the signal line **71** to a serial image signal and outputting the serial image signal to the differential output circuit **81** and a process of performing single conversion of a driving clock signal in a differential signal from the differential input circuit **82** to output a driving pulse signal.

Furthermore, the FPGA **61** executes a process of inputting ID information about the endoscope **31** and outputting the ID information to the differential output circuit **83**, a process of converting endoscope ID information about the endoscope **31**, adapter ID information in the ROM **14***a* and various parameters for adjustment in the flash memory **41***b* to serial

signals and outputting the signals to the differential output circuit **83**, according to a various information reading command from the differential input circuit **84**, and a process of writing the various parameters for adjustment to the flash memory **41***b* according to a various information writing command from the differential input circuit **84**.

Adapter ID information is stored in the ROM **41***a*. Therefore, the ROM **41***a* is an adapter identification information storage section which stores adapter identification information, which is identification information about the adapter **41**.

Furthermore, in the ROM **41***a*, driving pulse generation information, such as the pulse period and voltage of a driving signal corresponding to the kind of the image pickup device **32***a* of the endoscope **31** of the second type, is stored. This is because the pulse period and the like of a driving signal differ according to the kind, specifications and the like of the image pickup device **32***a*.

Note that the kinds of the image pickup devices **32***a* mounted on the endoscopes **31** are such that the period, voltage and the like of a driving signal is the same, the adapter **41** may not hold the driving pulse generation information.

Note that the processor **11** may hold the driving pulse generation information so as to provide corresponding driving pulse generation information for the adapter **41** on the basis of endoscope ID information from the adapter **41**.

The flash memory **41***b* stores various parameters for adjustment corresponding to a connected endoscope **31** as described later. More specifically, various parameters for adjustment for each of pieces of endoscope ID information about endoscopes **31** are stored in the flash memory **41***b*. Therefore, the flash memory **41***b* constitutes a parameter-for-adjustment storage section which stores parameters for adjustment.

Note that adapter ID information may be stored in the flash memory **41***b*.

FIG. **4** is a block configuration diagram of the FPGA **61**.

The FPGA **61** includes a control section **91**, a driver section **92**, parallel-serial converters (hereinafter referred to as a P/S converters) **93** and **94**, a serial-parallel converter (hereinafter referred to as an S/P converter) **95** and the interface (I/F) **96**.

The control section **91** reads driving pulse generation information corresponding to the image pickup device **32***a* of the connected endoscope **31** on the basis of endoscope ID information to control the driver section **92**.

The control section **91** performs a process of transmitting endoscope ID information about the endoscope **31**, adapter ID information and various parameters for adjustment to the processor **11** according to a transmission request command from the processor **11** and performing writing to the flash memory **41***b* according to a various-parameters-for-adjustment writing request command from the processor **11**.

Especially, when receiving a parameters-for-adjustment reading command from the processor **11**, the control section **91** executes a process of reading parameters for adjustment corresponding to endoscope ID information about the connected endoscope **31** from the flash memory **41***b* and transmitting the parameters for adjustment to the processor **11**.

Therefore, the control section **91** is a control section which performs control so as to store various parameters for adjustment received from the processor **11** into the flash memory **41***b* according to a parameters-for-adjustment writing command from the processor **11**, and read the various parameters for adjustment stored in the flash memory **41***b* and output the parameters for adjustment to the processor **11** according to a various-parameters-for-adjustment reading command from the processor **11**.

The driver section **92** is connected to the differential input circuit **82**. The driver section **92** inputs a driving clock signal from the processor **11**, performs single conversion of the signal and outputs a parallel driving pulse signal to the endoscope **31**. The driver section **92** constitutes an image pickup device driving signal generation circuit which generates a driving pulse signal, which is a driving signal for driving the image pickup device **32***a*, on the basis of a driving clock signal, which is a driving control signal from the processor **11**.

The P/S converter **93** is connected to the differential output circuit **81**. The P/S converter **93** inputs a parallel image signal from the image pickup device **32***a*, converts the parallel signal to a serial signal and outputs the serial signal to the processor **11**. Therefore, the A/D converter **73***b* and the P/S converter **93** constitute an image signal output circuit which converts an analog image signal from the image pickup device **32***a* to a digital image signal in a serial signal format and outputs the digital image signal to the processor **11**.

The P/S converter **94** is connected to the differential output circuit **83**. The control section **91** converts endoscope ID information, adapter ID information and various parameters for adjustment to serial signals and outputs the serial signals to the processor **11**.

The S/P converter **95** is connected to the differential input circuit **84**. The S/P converter **95** inputs various commands and various data from the processor **11**, converts the commands and data to parallel signals and outputs the parallel signals to the control section **91**.

(Processor Configuration)

FIG. **5** is a block configuration diagram of the processor **11**.

The processor **11** is configured to include: a control section **101** having a central processing unit (hereinafter referred to as a CPU), an image processing section **102**, a driving control section **103**, a driving section **104**, a video front end section (hereinafter referred to as a video FE section) **105**, a video back end section (hereinafter referred to as a video BE section) **106**, a timing generator (hereinafter referred to as a TG) **107**, a communication interface (hereinafter referred to as a communication I/F) **108** and a flash memory **109** which is a nonvolatile memory.

The control section **101** controls the whole processor **11** so as to realize various functions of the endoscope system **1** corresponding to operation instructions by the user. A white balance adjustment function is included in the various functions. The control section **101** performs a process of controlling the image processing section **102** and the driving control section **103** on the basis of various parameters for adjustment obtained as a result of white balance processing.

The video FE section **105** receives an image signal of an endoscopic image received via the connector portion **12***a* of the light source apparatus **12** and provides the image signal to the image processing section **102**.

The image processing section **102** performs predetermined image processing of the image signal from the video FE section **105** using various parameters for adjustment from the control section **101** and outputs the image-processed image signal to the video BE section **106**. The video BE section **106** generates an analog image signal and outputs the analog image signal to the monitor **13**.

The driving control section **103** generates a driving clock signal of each of image pickup devices of endoscopes using the various parameters for adjustment from the control section **101** and outputs the driving clock signal via the driving section **104**.

The TG **107** generates various timing signals for the image processing section **102** and the driving control section **103**.

The image processing section **102** and the driving control section **103** generate an image signal and a driving pulse signal, respectively, using the various timing signals from the TG **107**.

The communication I/F **108** is an interface circuit for communication of various data such as an operation signal, endoscope ID information, adapter ID information and parameters for adjustment. The control section **101** performs data communication with the endoscope **21** and the adapter **41** via the communication I/F **108**.

The flash memory **109** includes a table for storing adjusted endoscope information about endoscopes **21** of the first type and a table for storing adjusted combination information about combinations of endoscope **31** of the second type and adapter **41**. Configurations of the tables will be described later.

(Parameter-for-Adjustment Acquisition Process and Writing Process)

FIG. **6** is a flowchart showing an example of a flow of a parameter-for-adjustment acquisition and writing process of the processor **11**.

When the processor **11** is powered on, the process in FIG. **6** is executed. The process in FIG. **6** is performed by the CPU of the control section **101** executing a predetermined program stored in a ROM or the like not shown. When the processor **11** is powered on, the processor **11** can receive a signal from the connector portion **12***a* of the light source apparatus **12**.

When the processor **11** is powered on, the control section **101** outputs a predetermined command to read ID information in order to judge which of the endoscope **21** and the adapter **41** is connected to the connector portion **12***a* (S**1**). The reading of the ID information includes a case of reading endoscope ID information about the endoscope **21** and a case of reading adapter ID information about the adapter **41** and endoscope ID information about the endoscope **31**.

If the endoscope **21** receives the command for reading ID information from the processor **11**, the endoscope **21** reads endoscope ID information stored in the memory **25***a* and transmits the endoscope ID information to the processor **11**. If the adapter **41** receives the command for reading ID information from the processor **11**, the FPGA **61** transmits adapter ID information stored in the memory **41***a* to the processor **11**. The FPGA **61** also reads the resistance value of a resistor for identification of the connected endoscope **31**, via the buffer circuit **73***a*, converts the resistance value to a digital signal in the A/D converter **73***b* and transmits the digital signal to the processor **11** as endoscope ID information about the endoscope **31**.

Note that the endoscope ID information about the endoscope **31** may be obtained by recording the endoscope ID information about the endoscope **31** to a ROM provided in the endoscope **31** and providing means for reading information in the ROM for the adapter **41**.

Then, the control section **101** of the processor **11** judges whether the endoscope **21** of the first type is connected to the connector portion **12***a* or the endoscope **31** of the second type is connected via the adapter **41**, on the basis of the received ID information (S**2**). That is, when receiving only endoscope ID information, the control section **101** judges that the endoscope **21** of the first type is connected; and, when receiving both of adapter ID information and endoscope ID information, the control section **101** judges that the endoscope **31** of the second type is connected.

Note that a code showing that only an endoscope is connected and a code showing that an endoscope and an adapter are connected may be stored in each of the endoscope **21** and the adapter **41** to judge whether a connected endoscope is the endoscope **21** of the first type or the endoscope **31** of the second type.

If it is judged that the endoscope **21** of the first type is connected (S**2**: YES), it is judged whether or not the endoscope **21** is an endoscope connected for the first time, on the basis of the endoscope ID information (S**3**). Since adjusted endoscope information showing that an endoscope is an endoscope **21** which has been connected in the past and for which white balance adjustment has been executed is stored in the flash memory **109** of the processor **11**, the above judgment is performed on the basis of the information. The adjusted endoscope information stored in the flash memory **109** will be described later.

If the endoscope **21** is an endoscope connected for the first time or an endoscope for which white balance adjustment has not been executed yet (S**3**: YES), the control section **101** performs white balance (WB) processing (S**4**). In the white balance processing, white balance adjustment, gain adjustments among channels and the like are performed. The white balance processing is similar to conventional processing. Various parameters for adjustment obtained in the white balance processing include a coefficient for white balance adjustment, a coefficient for gain adjustment among channels and the like.

Then, the control section **101** writes the various parameters for adjustment obtained as a result of the white balance processing into the flash memory **25***a* of the endoscope **21** (S**5**), writes and stores the endoscope ID information into a table TBL**1** (to be described later) in the flash memory **109** as adjusted endoscope information (S**6**), and ends the process.

If the endoscope **21** is not an endoscope connected for the first time (S**3**: NO), the control section **101** reads parameters for adjustment from the flash memory **25***a* of the endoscope **21** (S**7**) and ends the process.

After the processes of S**6** and S**7**, the processor **11** is in a state capable of executing driving of the image pickup device and image processing of an image signal appropriately, using the various parameters for adjustment obtained by the white balance processing (S**4**) or read from the flash memory **25***a* (S**7**), and, therefore, the endoscope system **1** transitions to a state in which the user can perform endoscopy using the endoscope system **1**.

If the endoscope is not an endoscope of the first type (S**2**: NO), it is judged whether or not the combination of endoscope **31** and adapter **41** is a combination made for the first time on the basis of the endoscope ID information and the adapter ID information (S**8**). Since adjusted combination information showing that a combination is a combination of endoscope **31** and adapter **41** which has been connected in the past and for which white balance adjustment has been executed is stored in the flash memory **109** of the processor **11**, the above judgment is performed on the basis of the information. The adjusted combination information stored in the flash memory **109** will be described later.

If the combination of the endoscope **31** and the adapter **41** are a combination made for the first time (S**8**: YES), white balance processing similar to S**4** is performed (S**9**).

Then, the control section **101** writes the various parameters for adjustment obtained as a result of the white balance processing into the flash memory **41***b* of the adapter **41** (S**10**), writes and stores the endoscope ID information and the adapter ID information into a table TBL**2** (to be described later) in the flash memory **109** as adjusted combination information (S**11**), and ends the process.

If the combination of the endoscope **31** and the adapter **41** is not a combination made for the first time (S**8**: NO), the

control section **101** reads parameters for adjustment for the combination from the flash memory **41***b* of the adapter **41** (S**12**) and ends the process. At that time, when receiving a parameters-for-adjustment reading command from the processor **11**, the adapter **41** reads parameters for adjustment corresponding to endoscope ID information about the connected endoscope **31** and transmits the parameters to the processor **11**.

After the processes of S**11** and S**12**, the processor **11** is in a state capable of executing driving of the image pickup device **32***a* and image processing of an image signal appropriately, using the various parameters for adjustment obtained by the white balance processing (S**9**) or read from the flash memory **41***b* (S**12**), and, therefore, the endoscope system **1** transitions to a state in which the user can perform endoscopy using the endoscope system **1**.

Therefore, the control section **101** is a processing section which judges existence or nonexistence of adjusted combination information about a combination of endoscope identification information and adapter identification information received from the adapter **41** by referring to the table TBL**2** in the flash memory **109**; if the adjusted combination information does not exist, executes predetermined adjustment processing, stores parameters for adjustment obtained by the execution into the flash memory **41***b* of the adapter **41** and stores adjusted combination information about the combination of the endoscope identification information and the adapter identification information into the table TBL**2**; and, if the adjusted combination information exists, reads parameters for adjustment stored in the memory **41***b* of the adapter **41**.

Next, the adjusted endoscope information and the adjusted combination information will be described.

The flash memory **109** of the processor **11** stores two table data. One is a table for storing adjusted endoscope information about endoscopes **21** of the first type, and the other is a table for storing adjusted combination information about a combination of endoscope **31** of the second type and adapter **41**.

FIG. **7** is a diagram showing a configuration of a table for storing adjusted endoscope information about endoscopes **21** of the first type. The table TBL**1** stores endoscope ID information for which white balance processing has been executed at S**4** and various parameter data for adjustment have been written into the flash memory **25***a* of the endoscope **21** at S**5**.

If judging that an endoscope **21** is connected (S**2**: YES), the control section **101** refers to the table TBL**1** and checks whether endoscope ID information about the endoscope **21** exists or not. If the endoscope ID information exists in the table TBL**1** as a result of the checking, it is judged that the endoscope **21** is an endoscope **21** for which white balance processing has been already executed. If the endoscope ID information does not exist in the table TBL**1** as a result of the checking, it is judged that the endoscope **21** is an endoscope **21** connected and used for the first time.

FIG. **8** is a diagram showing a configuration of a table for storing adjusted combination information about endoscopes **31** of the second type and adapters **41**. The table TBL**2** stores information about combinations of endoscope ID information about endoscope **31** for which white balance processing has been executed at S**9** and parameters for adjustment have been written into the flash memory **41***b* of the adapter **41** at S**10** and adapter ID information about adapter **41**.

If judging that an endoscope **31** is connected via an adapter **41** (S**2**: NO), the control section **101** refers to the TBL**2** and checks whether a combination of adapter ID information about the adapter **41** and endoscope ID information about the endoscope **31** exists or not. If the combination of the adapter ID information and the endoscope ID information exists in the TBL**2** as a result of the checking, it is judged that the combination is a combination of the adapter **41** and the endoscope **31** for which white balance adjustment has been already executed. If the combination of the adapter ID information and the endoscope ID information does not exist in the TBL**2** as a result of the checking, it is judged that the combination is a combination of the adapter **41** and the endoscope **31** connected and used for the first time. Therefore, the TBL**2** constitutes an adjusted combination information storage section which stores adjusted combination information showing whether predetermined adjustment processing has been performed or not for a combination of endoscope identification information and adapter identification information.

As described above, similarly to the case of using the endoscope **21** which stores various parameters for adjustment, such as a white balance coefficient, in a built-in nonvolatile memory, the user can use the endoscope **31** which does not include such a memory, by using the adapter **41** without performing white balance adjustment each time he uses the endoscope **31**.

Note that, even in the case where, in a combination of the endoscope **21** and the processor **11**, an endoscope having a nonvolatile memory capable of storing only a part of parameters for adjustment to be stored into the flash memory **25***a* of the endoscope **21** is connected, it is possible to store parameters for adjustment which cannot be stored in the endoscope **21** or all parameters for adjustment required for combination with the processor **11** into the flash memory **41***b* of the adapter **41** by causing the adapter **41** to intervene. Therefore, the endoscope can be used with usability similar to that of the endoscope **21** of the first type.

(Variation)

Next, a variation of the adapter **41** will be described.

In the adapter **41** described above, the adapter body has the light guide **42** and the contact section **43** so that the adapter **41** is adapted to the light source apparatus **12** compatible with the endoscope **21** of the first type. However, the adapter **41** may be used in combination of the processor **11** compatible with the endoscope **21** of the first type and a light source apparatus compatible with the endoscope **31** of the second type. To cope with such a case, the adapter may be such that is used only for connection to the electrical connector of the endoscope **31** of the second type.

FIG. **9** is a diagram for illustrating a configuration example of an endoscope system **1**A using an adapter **41**A according to the present variation. FIG. **10** is a perspective view of the adapter **41**A. Note that, in FIG. **9**, the same components as those in the above embodiment are given the same reference numerals, and description thereof is omitted.

The endoscope system **1**A is configured with the processor **11**, a light source apparatus **12**A, an adapter **41**A and the endoscope **31** of the second type. The light source apparatus **12**A is a light source apparatus compatible with the endoscope **31**, and the light guide **36** of the endoscope **31** can be fitted to a connector portion **12***a***1**. The connector **12***a***1** supplies illumination light to the light guide **36**. The light source apparatus **12**A is connected to the processor **11** via a cable **14**A and can receive a control signal from the processor **11**.

The adapter **41**A is in a box shape and is connectable to the connector **35** of the endoscope **31** via a cable **45**A. The adapter **41**A is connectable to the processor **11** via a cable **45**B extended from the adapter **41**A. The adapter **41**A includes the circuit board **51**.

The cable **45**A has a connector **44***a* at one end. By inserting and fitting the connector **44***a* into a slot **41**A**1** of the adapter

41A, a contact section of the connector **44***a* is electrically connected to a contact section of the adapter **41**A, and the connector **35***a* and the circuit board **51** are electrically connected.

Therefore, the processor **11** and the endoscope **13** can exchange electrical signals via the adapter **41**A, and the circuit board **51** can receive various commands from the processor **11** and transmit endoscope ID information about endoscope **31**, and the like. Furthermore, the processor **11** can provide a driving signal to the image pickup device **32***a* and receive an image signal from the image pickup device **32***a* via the circuit board **51**.

Thus, according to the configuration as shown in FIG. **9** also, the user can use the endoscope **31** of the second type with usability similar to that of an endoscope of the first type, using the processor **11** compatible with the endoscope **21** of the first type.

As described above, according to the embodiment and variation described above, an adapter for endoscope, a processor for endoscope and an endoscope system can be realized which enable the user to use the endoscope connected to the processor, using the adapter with usability similar to the usability in the case of using an endoscope which stores various parameters for adjustment in its built-in nonvolatile memory.

The present invention is not limited to the embodiment described above, and various modifications, alterations and the like are possible within a range not departing from the spirit of the present invention.

What is claimed is:

1. An adapter for endoscope connecting an endoscope provided with an image pickup device which analog signals are inputted to and outputted from and a processor which digital signals are inputted to and outputted from, the adapter comprising:

an image pickup device driving signal generation circuit generating a driving signal for driving the image pickup device on the basis of a driving control signal from the processor;

an image signal output circuit converting an analog image signal from the image pickup device to a digital image signal in a serial signal format and outputting the digital image signal to the processor;

an endoscope identification information reception circuit receiving endoscope identification information which is identification information about the endoscope;

an adapter identification information storage section storing adapter identification information which is identification information about the adapter for endoscope;

an information transmission section transmitting the endoscope identification information and the adapter identification information to the processor;

a parameter-for-adjustment storage section storing parameters for adjustment; and

a control section performing control to store the parameters for adjustment received from the processor into the parameter-for-adjustment storage section according to a command to write the parameters for adjustment from the processor which is configured to receive the endoscope identification information and the adapter identification information, and read the parameters for adjustment stored in the parameter-for-adjustment storage section according to a command to read the parameters for adjustment from the processor and output the parameters for adjustment to the processor.

2. The adapter for endoscope according to claim **1**, wherein

the parameter-for-adjustment storage section stores the parameters for adjustment for each piece of the endoscope identification information; and

when receiving the reading command, the control section reads the parameters for adjustment stored in the parameter-for-adjustment storage section on the basis of the endoscope identification information and outputs the parameters for adjustment to the processor.

3. The adapter for endoscope according to claim **1**, further comprising a light transmission member transmitting light from a light source apparatus to a light guide of the endoscope.

4. The adapter for endoscope according to claim **1**, wherein the parameters for adjustment include a coefficient for white balance adjustment and a coefficient for gain adjustment among channels.

5. A processor capable of inputting and outputting digital signals to and from an adapter for endoscope to which an endoscope is connectable, the endoscope being provided with an image pickup device which analog signals are inputted to and outputted from, wherein

the adapter for endoscope comprises:

an image pickup device driving signal generation circuit generating a driving signal for driving the image pickup device on the basis of a driving control signal from the processor;

an image signal output circuit converting an analog image signal from the image pickup device to a digital image signal in a serial signal format and outputting the digital image signal to the processor;

an endoscope identification information reception circuit receiving endoscope identification information which is identification information about the endoscope;

an adapter identification information storage section storing adapter identification information which is identification information about the adapter for endoscope;

an information transmission section transmitting the endoscope identification information and the adapter identification information to the processor;

a parameter-for-adjustment storage section storing parameters for adjustment; and

a control section performing control to store the parameters for adjustment received from the processor into the parameter-for-adjustment storage section according to a command to write the parameters for adjustment from the processor which is configured to receive the endoscope identification information and the adapter identification information, and read the parameters for adjustment stored in the parameter-for-adjustment storage section according to a command to read the parameters for adjustment from the processor and output the parameters for adjustment to the processor; and

the processor comprises:

an adjusted combination information storage section storing adjusted combination information showing whether predetermined adjustment processing has been performed or not for a combination of the endoscope identification information and the adapter identification information; and

a control section judging existence or nonexistence of the adjusted combination information about a combination of the endoscope identification information and the adapter identification information received from the adapter for endoscope by referring to the adjusted combination information storage section; if the adjusted combination information does not exist, executing the

predetermined adjustment processing, storing the parameters for adjustment obtained by the execution into the parameter-for-adjustment storage section of the adapter for endoscope and storing the adjusted combination information about the combination of the endoscope identification information and the adapter identification information into the adjusted combination information storage section; and, if the adjusted combination information exists, reading the parameters for adjustment stored in the parameter-for-adjustment storage section of the adapter for endoscope.

6. The processor for endoscope according to claim **5**, wherein the parameters for adjustment include a coefficient for white balance adjustment and a coefficient for gain adjustment among channels.

7. An endoscope system comprising:

an adapter for endoscope to which an endoscope is connectable, the endoscope being provided with an image pickup device which analog signals are inputted to and outputted from; and

a processor which digital signals are inputted to and outputted from, wherein

the adapter for endoscope comprises:

an image pickup device driving signal generation circuit generating a driving signal for driving the image pickup device on the basis of a driving control signal from the processor;

an image signal output circuit converting an analog image signal from the image pickup device to a digital image signal in a serial signal format and outputting the digital image signal to the processor;

an endoscope identification information reception circuit receiving endoscope identification information which is identification information about the endoscope;

an adapter identification information storage section storing adapter identification information which is identification information about the adapter for endoscope;

an information transmission section transmitting the endoscope identification information and the adapter identification information to the processor;

a parameter-for-adjustment storage section storing parameters for adjustment; and

a control section performing control to store the parameters for adjustment received from the processor into the parameter-for-adjustment storage section according to a command to write the parameters for adjustment from the processor which is configured to receive the endoscope identification information and the adapter identification information, and read the parameters for adjustment stored in the parameter-for-adjustment storage section according to a command to read the parameters for adjustment from the processor and output the parameters for adjustment to the processor; and

the processor comprises:

an adjusted combination information storage section storing adjusted combination information showing whether predetermined adjustment processing has been performed or not for a combination of the endoscope identification information and the adapter identification information; and

a control section judging existence or nonexistence of the adjusted combination information about a combination of the endoscope identification information and the adapter identification information received from the adapter for endoscope by referring to the adjusted combination information storage section; if the adjusted combination information does not exist, executing the predetermined adjustment processing, storing the parameters for adjustment obtained by the execution into the parameter-for-adjustment storage section of the adapter for endoscope and storing the adjusted combination information about the combination of the endoscope identification information and the adapter identification information into the adjusted combination information storage section; and, if the adjusted combination information exists, reading the parameters for adjustment stored in the parameter-for-adjustment storage section of the adapter for endoscope.

8. The endoscope system according to claim **7**, wherein the parameters for adjustment include a coefficient for white balance adjustment and a coefficient for gain adjustment among channels.

9. The endoscope system according to claim **7**, further comprising a light source apparatus for supplying illumination light to the endoscope.

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